Polymers

more than rubber, rayon, and plastic

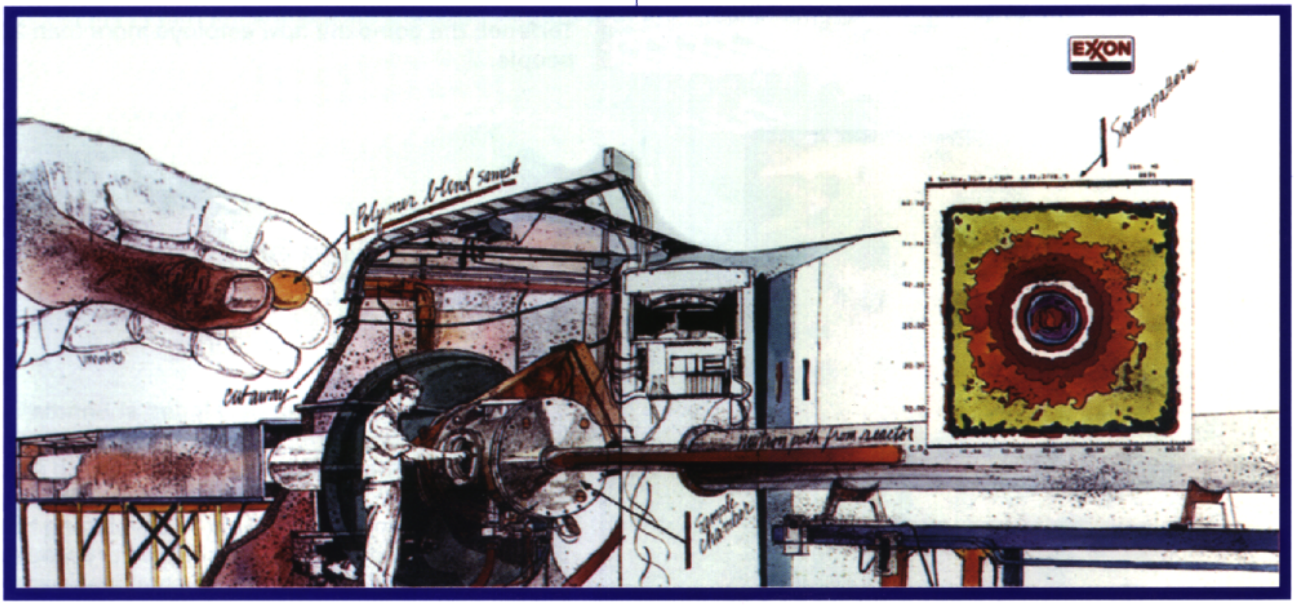
Synthesized from petroleum feedstock, polymers first gained public notice in the form of artificial rubber for tires, nylon and its offshoots for garments, and plastics for toys and containers. With the help of BES-funded research, companies are constantly searching for and finding new and improved polymers, as well as innovative ways to use these all-purpose materials.

Powerful BES computers and analytical tools can predict and measure the composition and structure of the basic polymer (long-chain) molecule, the ways in which the chains fold and link up as they take on solid form, and the ability to mix and blend different polymers synergistically to combine the best properties of each.

Reinforced concrete is a prototypical composite material; it's made from a strengthening element — in this case, steel — embedded in a matrix that provides it a basic structure. BES scientists are working with their industrial colleagues to perfect ways to manufacture polymer composites (modeled after concrete). One example is polymer-ceramic composites that serve as lightweight, flame-retardant structural materials for aircraft and housing.

Anyone with a non-stick frying pan appreciates that coatings provide another way to combine the good features of polymers with those of other materials, but they also understand that the quality of the bond between the coating and the underlying substrate determines the usefulness of the product. BES researchers are working to develop new bonding techniques for products from microchip packages to large structural parts.

The automobile of the future may be far more plastic than it already is, thanks in part to BES-supported research. Prospective uses for polymer materials include rechargeable batteries, flat-panel displays, wear-resistant plastic parts, and polymer-coated particles in lubricating oils. The fuel efficiency that goes with reduced weight is critical to maintaining and strengthening the market share of the U.S. automotive industry.



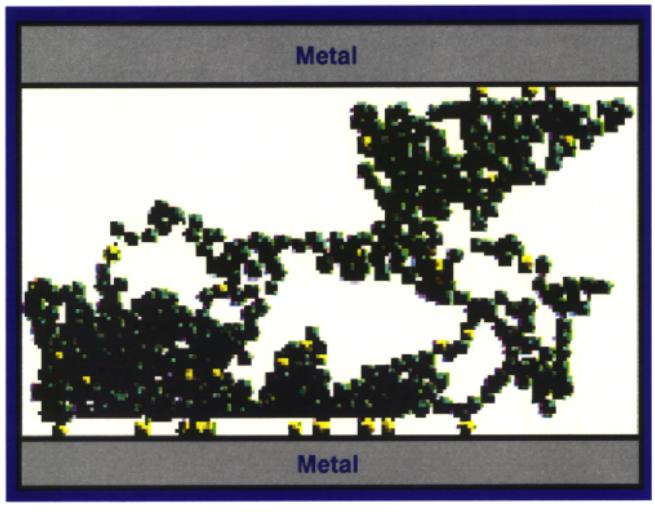
Industry increasingly has explored combining (blending) polymers to achieve new materials with improved properties. Research at the small-angle neutron scattering facilities at the Oak Ridge National Laboratory's High Flux Isotope Reactor has led to significant advances in the understanding and design of polymer blends for more than a dozen companies, including Exxon.

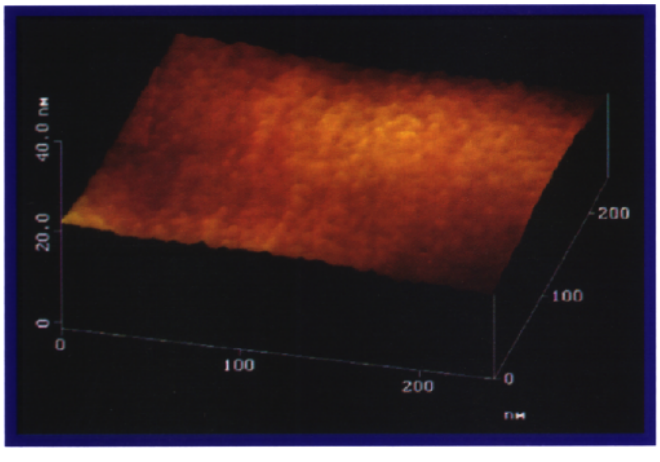
Advanced Batteries

Brookhaven National Laboratory and the Moltech Corporation worked together under a cooperative research and development agreement to evaluate polymers for use in rechargeable lithium batteries as electrodes and electrolytes to conduct lithium ions between the electrodes. The polymers developed at Brookhaven for this purpose are much lighter than metal electrodes and have far higher conductivity than other materials.

Adhesives

In research supported by Alcoa, Amoco, Ford, Inland Steel, and UTC, scientists at the University of Illinois Materials Research Center are investigating how polymer molecules are bonded to metal surfaces with the goal of making stronger adhesives, as in this computer simulation of a polymer adhesive between metal plates being pulled apart.





Polymer Composites

Pacific Northwest National Laboratory has developed a new water-based processing method for making polymer-glass composite materials. This new method is environmentally and economically advantageous, compared to current practices. It also results in increased uniformity, enhanced performance, and ease of fabrication because of the fine grain structure, which is evident in this image taken with an atomic force microscope.